Cost Reduction of IMM Solar Cells by Recycling Substrates Using Wet Chemical Etching, Phase II Project

SBIR/STTR Programs | Space Technology Mission Directorate (STMD)

ABSTRACT

The goal of the program is to reduce the cost of substrate reclaim for high-efficiency solar cells fabricated by an epitaxial lift-off (ELO) process, and to increase the number of reuse cycles for a given substrate. If successful, this will result in a reduction in the cost of GaAs-based multi-junction solar cells, in which the cost of the substrate accounts for approximately 50% of the total cost. The cost reduction is achieved by introducing a new multi-layer etch-stop structure into a inverted metamorphic (IMM) triple-junction cell. The etch-stop structure is grown between the original GaAs substrate and the ELO release layer, thereby becoming the effective substrate surface after the ELO process. The etch-stop structure prevents pits and surface damage that occur during ELO from damaging the surface of the GaAs substrate. The standard method of reclaiming the GaAs substrate after ELO is to employ chemo-mechanical polishing (CMP) to remove the defect-ridden GaAs surface and chemically polish the underlying GaAs to yield a surface that is suitable for epitaxial growth. The CMP process works but reduces the substrate thickness and causes minor wafer damage itself, which requires further polishing. These factors accumulate, in practice limiting the number of reclaim cycles to 5 - 10 for a given substrate. With the incorporation of the proposed etch-stop structure, the defects are isolated in the etch-stop structure, which can be dissolved by successive selective wet chemical etches to produce the original pristine GaAs surface on a substrate of the original thickness. All mechanical polishing is eliminated in this proposed work, ensuring a constant substrate thickness through repeated substrate reclaim cycles and reducing the estimated cost of the recycling process to <$1 per substrate. The Phase I program demonstrated that this method for substrate reclaim works; in Phase II we will develop the reclaim into an optimized batch process.

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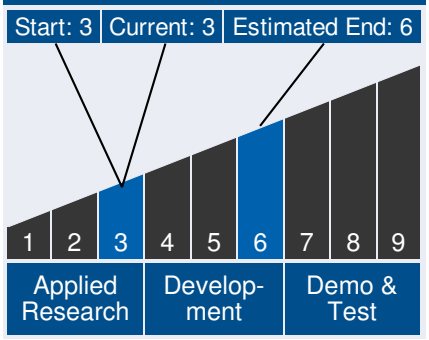
Technology Maturity



Management Team

Program Executives:

- Joseph Grant
- Laguduva Kubendran

Program Manager:

- Carlos Torrez

Continued on following page.

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ANTICIPATED BENEFITS

To NASA funded missions:

Potential NASA Commercial Applications: The main consequence of the technology to be developed in the proposed program is to reduce the cost of the lightweight, high-efficiency epitaxial lift-off (ELO) solar cells that are manufactured using the ELO process also developed by MicroLink. As they provide similar performance at a lower cost and far lower mass, ELO solar cells are a good candidate for replacing the conventional multi-junction, Ge-based solar cells that are used in many NASA applications. In addition, ELO solar cells are an enabling technology for the proposed new generation of lightweight, high-efficiency solar panels which will critical for solar electric propulsion (SEP) applications. One of the barriers to the introduction of SEP is cell cost; the proposed reclaim technology should reduce the cost of the solar cell by several dollars per watt compared with the cost that can be achieved with ELO alone.

To the commercial space industry:

Potential Non-NASA Commercial Applications: The reduced cost ELO solar cells that will result from the proposed program will have multiple non-NASA commercial applications. The low-cost, lightweight, high-efficiency ELO cells made using the proposed substrate reclaim process are a good candidate for replacing the conventional multi-junction, Ge-based solar cells that are used in many commercial applications. Lightweight, high-efficiency ELO solar cells are used to substantially enhance the endurance of small, electrically powered unmanned aerial vehicle (UAV) applications. A major barrier to the adoption of solar cell technology is cost; reducing the cost of the solar cells will speed their adoption in small UAV applications. Similarly, lightweight, high-efficiency solar cells are an enabling technology for high altitude, long endurance (HALE) UAVs, such as the DARPA Vulture. Solar cells are a major component of the bill of materials for such HALE UAVs; reducing cell cost is critical to the adoption

Management Team *(cont.)*

Project Manager:

- Anna maria Pal

Principal Investigator:

- Alex Hains

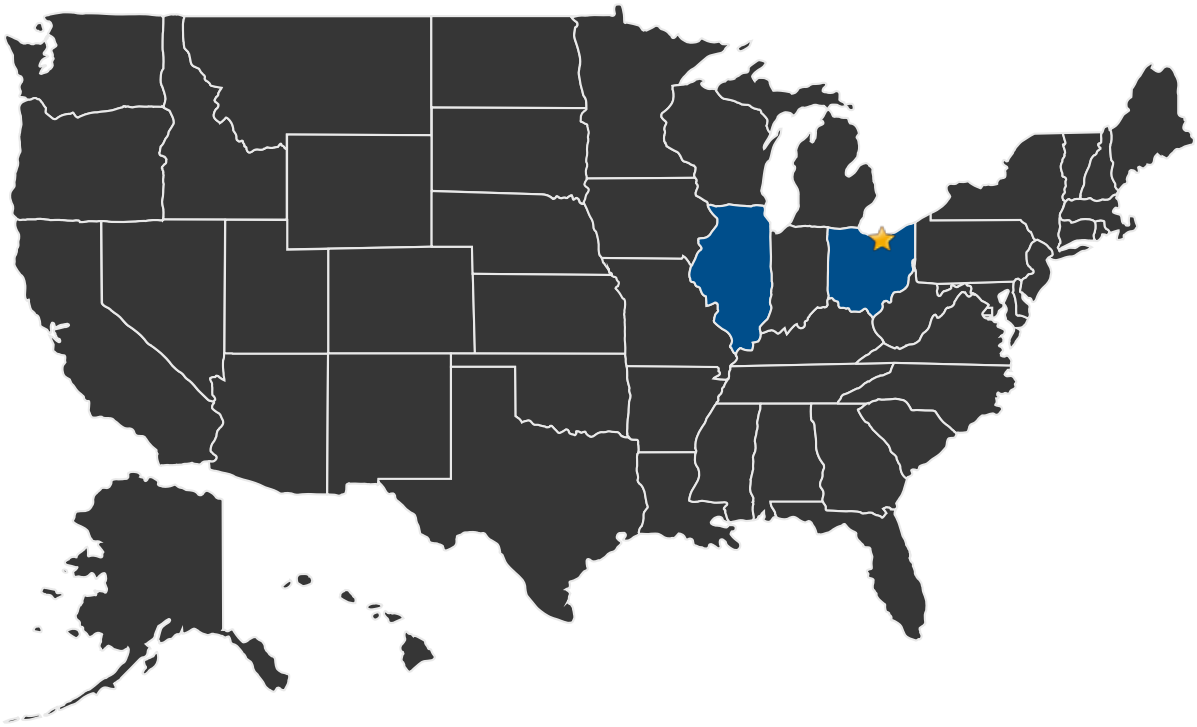
Technology Areas

Primary Technology Area:

Space Power and Energy Storage (TA 3)
└ Power Generation (TA 3.1)
  └ Solar (TA 3.1.3)
    └ Ultra-High-Efficiency Photovoltaic Blankets (TA 3.1.3.10)

of this technology by the commercial sector. Lightweight, high-efficiency solar cells may be used in solar sheets for generation of electricity for high-value, off-grid applications, such as power generation for military field deployments, civilian outdoors and camping, and supplementary power for mobile devices such as phones. The cost reduction enabled by low-cost substrate reclaim will increase the appeal of solar sheet technology.

U.S. WORK LOCATIONS AND KEY PARTNERS



U.S. States With Work

Lead Center:
Glenn Research Center

Other Organizations Performing Work:

- MicroLink Devices, Inc. (Niles, IL)

PROJECT LIBRARY

Presentations

- Briefing Chart
  - (http://techport.nasa.gov:80/file/23055)

IMAGE GALLERY

Cost Reduction of IMM Solar Cells by Recycling Substrates Using Wet Chemical Etching, Phase II

DETAILS FOR TECHNOLOGY 1

Technology Title

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Potential Applications

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